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EC97-1874 Diseases Affecting Grain and Seed Quality in Wheat

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Diseases Affecting Grain and Seed Quality in Wheat

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Seed-associated diseases of wheat draw considerable attention because they often reduce both grain quality and yield. In addition ergot and scab diseases bring in a third dimension because toxins associated with each present a potentially serious health risk to humans and animals. Yield losses caused by smuts are roughly equal to the percentage of smutted heads in the field; however, losses from black point, scab or ergot are less easily measured. For example, wheat in the soft dough stage that is infected by one of the scab pathogens may still produce plump, good test weight kernels resulting in minimal yield loss. The down side is that the toxin level in the harvested grain may be higher in these plumper kernels than in the shriveled kernels infected at flowering because many shriveled kernels are lost during combining.

Not all seed-borne or seed-associated diseases are identified in *The Official United States Standards for Grain*. Three terms which do appear in these standards are "light smutty wheat", "smutty wheat" and "ergoty wheat". The definition of each is clearly defined in the special grade designations. If harvested grain falls into one of these three categories, it will be discounted or possibly even rejected by the elevator.

Head disease incidence is related to wet weather during the flowering and grain filling stages and has increased in the Midwest in recent years. These head diseases include black point, ergot, scab and common bunt. The incidence of loose smut, which is not dependent on wet weather at heading, remains relatively low in Nebraska. Many varieties are resistant to loose smut.

Black Point

Black point is the descriptive term that refers to the darkened pericarp and often shriveled embryo end of wheat seed. It was first described in the United States in 1913. Other terms used to describe this disease are smudge or kernel smudge. Several fungi have been associated with black point, however, *Alternaria alternata*

and *Bipolaris sorokiniana* are considered the primary causal agents.

The disease adversely affects grain and seed quality. Infection by *A. alternata* affects milling quality because it reduces the nitrogen, gluten, fatty acid, potassium, calcium, zinc and manganese content of the grain. Discolored grain is discounted in value because the milled flour contains dark specks. In U.S. Wheat Grades No. 1 and No. 2, only 2 percent and 4 percent, respectively, of darkened kernels are allowed. *B. sorokiniana* doesn't seriously affect grain quality, but may cause seed rot and reduce seedling emergence if infected kernels are planted.

Figure 1. Black point.

Key Symptoms

- Dark brown discoloration around the embryo end of the seed and near the brush and along the crease (*Figure 1*).
- Endosperm turns brownish-gray.
- Infected seeds fail to germinate.
- Dark brown discoloration on the coleoptible of infected seedlings.

Prolonged rainfall during seed maturation (early milk —soft dough) favors black point. Wet weather promotes sporulation (production of new spores) and infection by the black point-causing fungi. These fungi are endemic to soils and crop residue which ensures a source of pathogen inoculum.

Control

- Store seeds under dry conditions.
- Have suspect seed tested for germination using standard germination tests.
- Do not use black pointed wheat for seed.
- Fungicide seed treatments will improve seed germination and reduce seedling infection.

Ergot

The ergot fungus, *Claviceps purpurea*, is endemic to the Great Plains wheat producing region of North America. The disease occurs, to some extent, every year in cereal grains and pasture and roadside grasses in Nebraska. Rye is the principal small grains host. Spores of the ergot fungus infect floral tissues prior to fertilization or within the first few days after

fertilization. The closed glumes of self-pollinated grasses such as wheat present a physical barrier to infection resulting in a relatively low incidence of ergot in wheat. However, commercial winter wheat varieties grown in Nebraska are not immune to infection and the disease occasionally causes problems with grain quality. Ergot is a potential threat to hybrid wheat production because the open-floreted, male-sterile wheat lines used for hybrid seed production are often susceptible.

Figure 2. Ergot.

Key Symptoms

- Initial symptoms are the presence of thick, amber-colored droplets called "honeydew" exuding from infected spikelets and adhering to the head.
- Purple-black ergot bodies called sclerotia protruding from the glumes of mature heads.
- Intact or broken, black to purple-black sclerotia in the harvested grain (*Figure 2*).
- Sclerotia may be similar in size and shape to a wheat kernel, or they may be more irregularly shaped and larger than the kernel.

Primary infections come from spores produced by germinating sclerotia on the soil surface. Secondary infections originate from spores produced in the honeydew that are wind blown or rain splashed to nearby wheat heads. Infected grasses in roadsides, waterways or fence rows probably furnish much of the primary and some of the secondary source of spores infecting adjacent wheat. Sclerotia from the previous year's infections present on the soil surface germinate in response to moisture. If heading of the grasses roughly coincides with that of the wheat, both crops may become infected. More likely, spores in the honeydew of infected grasses are blown into receptive wheat heads at flowering.

Wheat heads are most susceptible just before anthesis. Cool, cloudy weather that accompanies or prolongs flowering in the grasses and wheat favors honeydew formation and infection.

Not all the sclerotia in harvested wheat may have originated from infected wheat heads. Some of the sclerotia may be from infected grasses or rye in the field and mixed in with the wheat, contaminating the grain and causing the wheat to be graded as ergoty. Ergot sclerotia from grasses usually are more slender or flattened in shape than those produced in wheat, whereas those from rye are usually fairly large.

Control

- Mow grasses in headlands, roadsides and waterways before they head.
- Survival rate of sclerotia on the soil surface is about one year, so crop rotations or longer (14 month) fallow periods reduce the risk of carryover infections from sclerotia within the field.

- Modern seed cleaning methods remove many, but not all sclerotia.
- Removal of sclerotia by flotation in a brine (20 percent salt solution) is useful for small high value seed lots. The sclerotia float and the grain sinks in the brine solution.

Federal grain standards classify wheat as ergoty if the harvested grain contains more than 0.30 percent of ergot. These low tolerances are necessary because the ergot bodies contain several compounds (alkaloids) that are toxic to humans, but ergotism in livestock is a very real threat; probably, more from feeding ergot-infested hay than from ergot-infested wheat. Feed containing 0.10 percent ergot bodies should be regarded as dangerous. It is best if livestock producers adopt a zero tolerance for ergot in either hay or feed grains. Any suspect hay or grain can be assayed for ergot alkaloids by the following laboratory:

Veterinary Diagnostic Center
University of Nebraska
P.O. Box 83097
Lincoln, NE 68583-0907

Common Bunt

Common bunt or striking smut, as it is sometimes called, rarely causes large yield losses in the Great Plains, but the disease can be an important factor in reducing grain quality. It is second only to leaf rust in worldwide importance. The presence of common bunt in harvested wheat is a problem for the farmer because the wheat is usually discounted or rejected by the elevator. Although the bunted grain is not toxic, livestock often refuse to eat it because of the strong odor and low palatability.

Figure 3. Common bunt.

Large masses of bunt spores are easily ignited and have caused explosions and fires in grain storage facilities. Workers handling bunted grain must wear dust masks because inhalation of spores may create respiratory problems for people with allergies. When milled, bunted grain produces off-white flour with an objectionable odor.

Common bunt, caused by *Tilletia tritici* or *T. laevis*, was one of the first wheat diseases shown to be caused by fungi. Seed was treated with copper sulfate as early as 1761 to control common bunt.

Key Symptoms

- Bunted heads are slender, have an open appearance and stay green longer than healthy heads.
- Glumes are normal in size and shape but are more open on infected heads.

- Seed contaminated with bunt spores has a darkened appearance and a pungent odor of decaying fish.
- Bunt balls in harvested grain are dull gray and the approximate shape of normal kernels. (*Figure 3*).
- Cloudy masses of black spores may be present during harvesting.

Because it requires cool, moist soil conditions for infection, common bunt is less of a problem on spring wheats than on winter wheats. The disease cycle is similar to that of other covered smuts of small grains. When infected grains are harvested, the bunt balls break and contaminate the grain, combine, storage facility and soil with spores. In the field the bunt spores can survive up to two years in arid regions. If the infected seed is planted, the spores on the seed coat or in the soil germinate in response to moisture. The mycelium penetrates directly through the cuticle of the seedling coleoptile before emergence. Optimum temperatures for spore germination and mycelial infection of the coleoptile are 42-50° F (6-10° C). The fungal hyphae grows within the terminal meristem (growing point) of the developing wheat plant and eventually colonizes the developing ovary where it displaces the seed tissues with spores. There are no signs or symptoms of infection until the head matures. Normally, tillers also are infected and entire plants, including heads, are smutted.

Control

- Treat seed with fungicides containing hexachlorobenzane (HCB), pentachloronitrobenzene (PCNB), caboxin (Vitavax) or difenoconazole (Dividend) to control both soil- and seed-borne inoculum.
- Plant cleaned/certified seed harvested from common bunt-free fields.

Loose Smut

Like common bunt, loose smut, caused by *Ustilago tritici*, also is a seed-borne disease of wheat. *U. tritici* is unique among the wheat smuts in that it it is incorporated into the developing kernel and persists inside the seed. Affected seeds show no symptoms and outwardly appear healthy. Generally, yield losses attributed to loose smut in the Great Plains are low, i.e. less than 1 percent annually. Unlike common bunt, the presence of *U. tritici* in seed has little effect on grain quality for milling or feed, but the infected seed should not be used for planting without first being treated with a systemic fungicide.

Figure 4. Loose smut.

Key Symptoms

- Smutted heads are transformed into olive black masses of smut spored only visible at heading (*Figure 4*).

- Initially, the spore masses are covered by delicate gray membrane that soon breaks.
- After the membrane ruptures, the spores are dislodged leaving behind the naked rachis and some spores clinging to fibers of the head.
- When spikelet tissues are not completely destroyed, the rachis may bear remnants of glumes and awns.
- All or only a few of the heads on an infected plant may be transformed into smut spores.

The disease cycle starts with the planting of smut-infested seed. Mycelium of *U. tritici* is present in all parts of the seed. When infected seed germinates, dormant mycelium in the seed embryo becomes active and growth keeps pace with the growing point of the developing seedling. When the growing point terminates in a head, the fungus replaces the grain and other tissues with a mass of spores. Smutted heads emerge slightly earlier than healthy heads. Spores from these heads are blown to noninfected heads during flowering where they germinate and become established as dormant mycelium in the developing kernel. Infection is favored by humid, moderate (60-70° F, 16-22° C) weather during flowering.

Other than symptoms, loose smut differs from common bunt in that it is an embryo-infecting pathogen that is carried inside the seed as dormant mycelium. Common bunt is a seedling-infecting pathogen that is carried inside the seed as dormant mycelium. Common bunt is a seedling-infecting pathogen that is carried as spores on the outside of the seed coat or in the soil.

Control

- Treat seed with a systemic fungicide registered for loose smut control.
- Inspect wheat during flowering to detect smutted heads.
- Plant cleaned/certified seeds from smut-free fields.

Scab

Wheat scab or Fusarium head blight is caused by several species of *Fusaria*; those of most importance to the Great Plains are *Fusarium graminearum*, *F. culmorum* and *F. avenoceum*. These pathogens occur as soil inhabitants as well as saprophytes on crop residues and are always present. In addition to causing scab, they also cause seed decay, seedling blight and crown and root rot of wheat; and stalk and ear rots of corn and sorghum.

Figure 5. Scab.

In recent years major epidemics have occurred on spring wheat in the northern Great Plains and sporadic outbreaks have occurred in winter wheat in the central Great Plains. The disease has become endemic in eastern and central

Nebraska, although direct yield losses are often minor. The economic significance of scab is manifested both by its effects on seed and grain quality. Grain from blighted fields has reduced value as a seed crop, since blighted seedlings may develop from *Fusarium*-infected seed. Scabby grain may contain mycotoxins which reduce its milling and feed value. Losses associated with these mycotoxins are often underestimated because even lightly infected grain can cause mycotoxiosis in animals and humans that consume scabby grain or grain products. Individuals that grind wheat for their own consumption must be alert to this potential danger.

Key Symptoms

- Manifests itself in the field by the premature blighting or senescence of individual spikelets or portions of heads after the soft dough stage.
- Glumes are more open and dull in appearance.
- Brown discoloration of the peduncle (neck) that kills the entire head.
- During warm humid weather, pink to orange fungus mycelium forms as a ring at the base of spikelets or along the edge of glumes.
- Infected grains are light weight, shriveled and chalky white to pink in color (*Figure 5*).

Wheat heads are susceptible to infection by airborne *Fusaria* spores from anthesis (flowering) to kernel soft dough stage. Infection is favored by continuous head wetness and extended moderately warm (68-86° F, 20-30° C) weather. The longer the wheat plants stay wet during flowering and soft dough stage, the greater the change of infection and increased severity.

Corn, sorghum and wheat residue play an important role in the survival and buildup of inoculum in areas where those crops overlap. The spores produced on these residues during wet weather at wheat flowering are blown to the heads.

Infection during the soft dough stage does not significantly shrivel the kernel. Because these kernels remain with the harvested grain rather than being lost during combining as are the shriveled grains they present a higher risk of contaminating mycotoxins. Also, their value as a seed crop is questionable because of the seedling blight potential. Any grain in these categories should be screened for mycotoxins and tested for germination.

Control

- Increase airflow in the combine to remove as many as possible of the shriveled, scabby kernels.
- Use crop rotations in which wheat does not follow wheat, corn or sorghum.
- Inspect seed production fields.
- Treat seed with a benzimideazole- or difenoconazole-containing fungicide.
- Have grain from suspect fields tested for mycotoxins and germination by a professional laboratory.

Seed Quality and Testing

The importance of using food quality seed cannot be minimized. Effective risk management dictates that

you control as many of the inputs in your cropping system as possible. Seed quality is one factor that influences yield. As a farmer, you influence your chances for a higher yield when you select seed. Using healthy, high quality seed optimizes your chances of obtaining high yields. The phrase "high quality seed" means different things to different people. High quality seed is not perfect, but it is reasonably pure genetically and mechanically, and has met minimum quality standards for germination, purity and weed seed. In addition, it has been tested for disease-causing pathogens. Because it is genetically pure and is a known variety, the area of adaptability is also known, so it can be produced where the growing conditions are best for that variety. The higher genetic purity also ensures that you have the plant characteristics that are best suited for your specific farming practices, i.e. maturity range, straw height, protein characteristics, disease and insect resistance.

Planting "bin-run" wheat seed that has not been tested for quality factors, is of questionable genetic purity, is several generations from the breeder seed, or has not been properly conditioned through air screening will lessen the likelihood of obtaining a good stand and high yields. You also may be planting a number of undesirable weeds back into your farm, or obtaining them from other's bin-run grain.

The use of "certified" seed that has been quality checked in the field and in the laboratory is your best assurance of planting healthy, high quality seed. All certified seed has been checked for genetic purity, mechanical purity and viability. Seed contaminating noxious or undesirable weeds such as jointed goatgrass or rye seed cannot be marketed as certified seed.

Seed is a very low proportion of total production costs. High quality seed usually does not cost as much in the long run as bargain seed or low priced seed lots. In the end, low quality seed can be expensive in terms of poor stand establishment and future problems with weeds and diseases.

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